Practical Approaches for Probabilistic Tsunami Hazard and Risk Assessment

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Background

Large-scale probabilistic tsunami hazard and risk assessment (Fig1.) require many numerically-intensive simulations of the seismically induced tsunami events, involving tsunami phases of **(A)Generation, (B)Propagation and (C)Inundation** on the coast which are not always feasible unless large computational resources like HPCs are at ones disposable.

The advancements in computational and numerical methods like parallel processing, GPUs, unstructured meshes and nesting techniques etc. help to undertake a regional PTHA on large portions of the coast involving multiple sources zones, but we still need concepts and algorithms for reducing the number of events simulated, or rapidly approximating the simulations results.

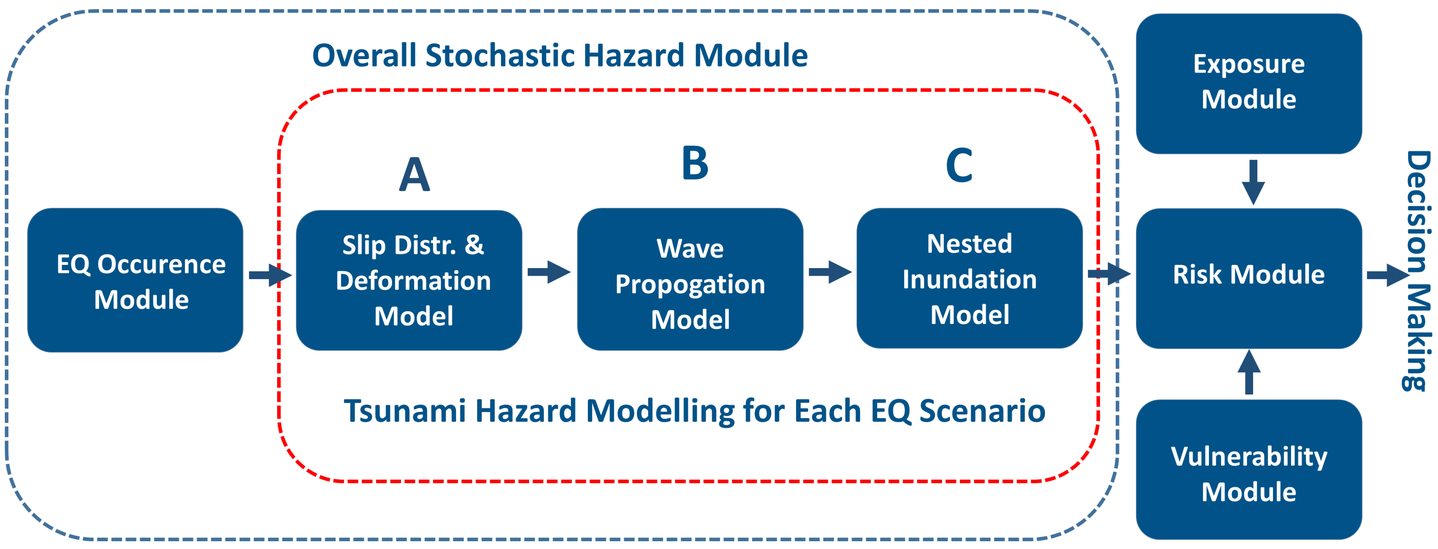

Figure 1. *Workflow of probabilistic tsunami risk assessment(EQ sources)*

Handling the Challenge of Scales

This computational challenge of scales (highlighted in Fig.1 of hazard module as red) is not foreign and previous works have handled them in different ways, mainly: **(1) Reducing the number of scenarios modelled for inundation (2) Using approximation methods(amplification factors) (3) Surrogate modelling(emulators)** but are limited to application in localized studies or forecasting.

This PhD work proposes to revisit such methods and explore a data driven approach for the event based risk modelling, with a focus on understanding the impact of using them on the probabilistic estimates of tsunami hazard/risk and further to evaluate their performance in comparison with the traditional approaches for a test region.

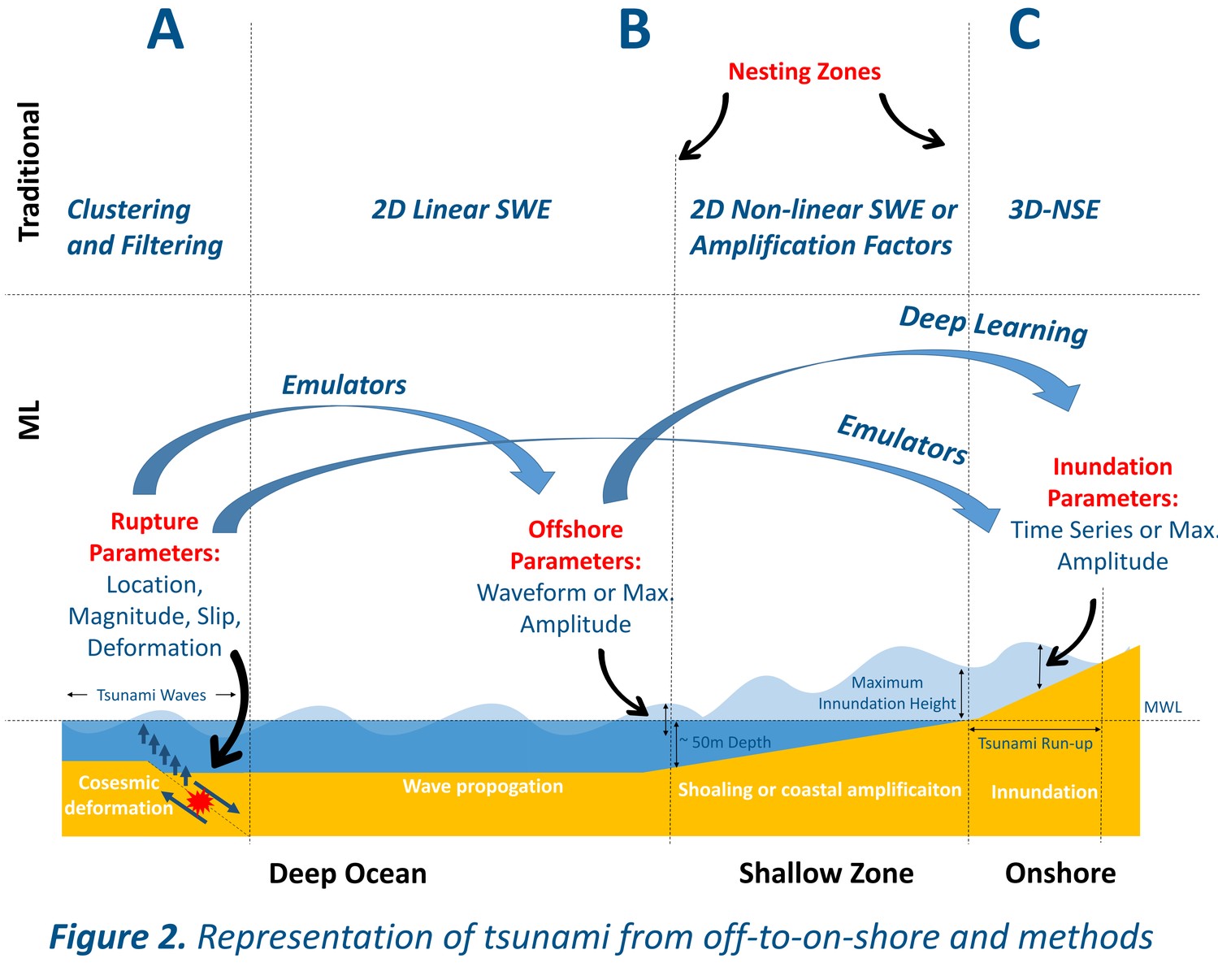

Figure 2. *Representation of tsunami from off-to-on-shore and methods*

Open questions?

This current work culminates into an optimization problem of sorts, where our means are limited by the available data, modelling methods and computational resources. The avenue of data driven methods and ML brings new possibilities and have shown great potential as seen in recent examples for tsunami forecasting but with respect to PTRA: *Can we design experiments efficiently to train the machine learning algorithms to offset the computational cost? Develop a smart hybrid solution utilizing traditional modelling with machine learning methods? Are we reducing the uncertainty by adding such black-boxes in our modeling chain ?*

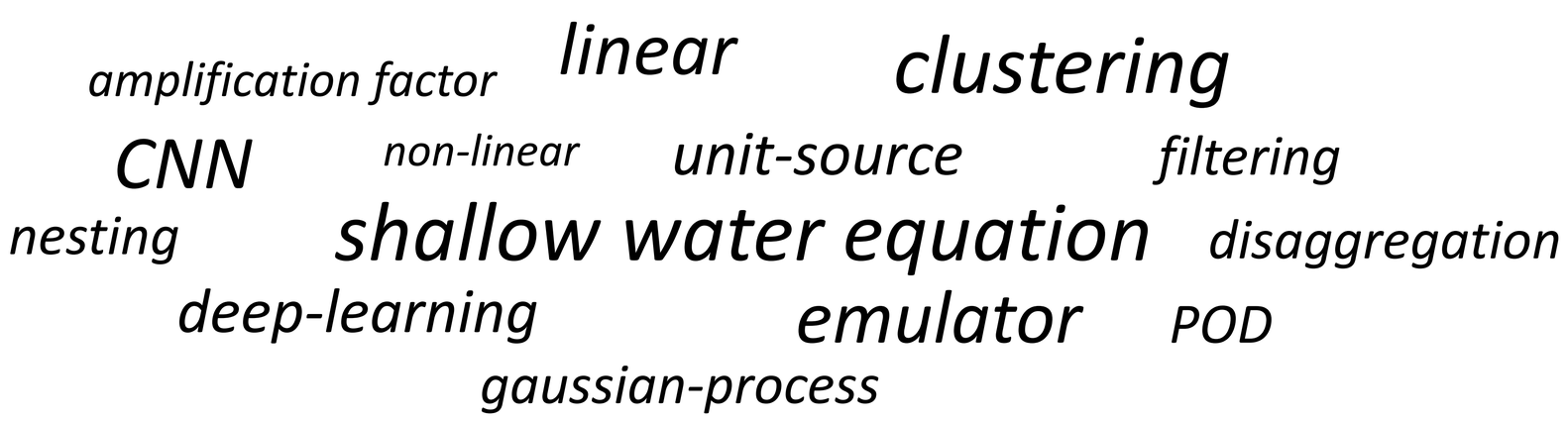

Figure 3. *A word cloud of methods used in probabilistic tsunami hazard modelling*